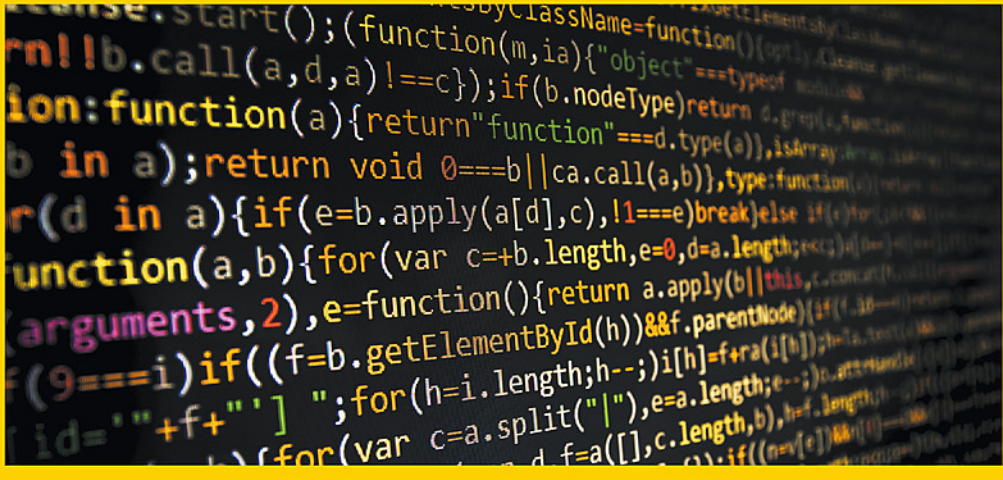
HORST EIDENMÜLLER /
GERHARD WAGNER

Law by Algorithm



Mohr Siebeck

Horst Eidenmüller and Gerhard Wagner

Law by Algorithm

Horst Eidenmüller and Gerhard Wagner

Law by Algorithm

Mohr Siebeck

Horst Eidenmüller is a Statutory Professor for Commercial Law at the University of Oxford and a Professorial Fellow of St. Hugh's College, Oxford.

Gerhard Wagner holds the Chair for Private Law, Business Law, and Law and Economics at Humboldt University of Berlin.

ISBN 978-3-16-157508-2 / eISBN 978-3-16-157509-9
DOI 10.1628/978-3-16-157509-9

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliographie; detailed bibliographic data are available at *http://dnb.dnb.de.*

The book was typeset by Epline in Böblingen using Minion typeface, printed on non-aging paper and bound by Gulde-Druck in Tübingen.

Cover illustration: Photo 93689313 © Krisana Antharith.

Printed in Germany.

Preface

This book is about a development which is as fascinating as it is frightening: laws and contracts made – or at least deeply influenced – by computer code. "Law by Algorithm" investigates the impact of digitization, blockchain technology and Artificial Intelligence (AI) on lawmaking, legal scholarship, and legal practice.

About two decades ago, the phrase "Code is Law" was coined to denote the normative autonomy of the Internet/Cyberspace.[1] "Law by Algorithm" goes further. It is not just that certain technologies are beyond the reach of lawmakers and regulators. Human actors use sophisticated new technologies to make and shape laws and contracts. And machines may eventually even replace human lawmakers. Self-driving cars are already on our roads. When will algorithmic judges populate our courts? Would this be an improvement and, if so, for whom?

It is certainly not too early to start thinking about these and related questions. Digitization, blockchain technology and AI applications have been turbocharged in the last two years by the COVID-19 pandemic. Big Tech, i. e. Google, Apple, Facebook, Amazon and Microsoft, is leveraging its power by deploying sophisticated new technologies to shape the legal code of private transactions in its favor. How should societies address this development?

This book explores the multifaceted challenges of "Law by Algorithm". What exactly is happening in terms of technological developments, and what are the law-related developments that we can observe? Which new challenges to legal doctrine and to regulation arise? What use can societies make of AI in lawmaking and the application of laws?

These are the main themes of our inquiry. We analyze conceptual and philosophical questions of "robot law", investigate the (potentially negative) impact of Big Data and AI applications on consumer welfare, examine liability questions related to the rise of autonomous systems and associated conceptual issues, and deal with the impact of AI on corporate governance and corporate law. We also assess the prospect for "driverless arbitrations", smart contracts and digital enforcement, internal complaint handling, Online Dispute Resolution

[1] See Lawrence Lessig, *Code is Law: On Liberty in Cyberspace*, Harvard Magazine 1.1.2000, https://www.harvardmagazine.com/2000/01/code-is-law-html (last visited on September 30, 2021).

(ODR) and the role of the courts in a world shaped by digitization, blockchain technology and AI applications.

The majority of the book's chapters have already appeared elsewhere as articles, and we acknowledge the original publication in the first footnote of each chapter and at the end of the book. The book also contains new contributions, which have not appeared elsewhere before, namely the Introduction (Chapter 1), Chapter 7 on "AI Liability" and Chapter 10 on "Digital Dispute Resolution".

A recurring theme of our analysis is that although "Law by Algorithm" might massively increase overall societal welfare, it runs the significant risk of benefitting only a few. To make it work for the good of all is a mammoth and complicated task. We are private law scholars who work on the law of contracts and torts, on commercial and corporate law, and on the manifold mechanisms of dispute resolution. While much of the scholarly and policy discourse on regulating Big Tech, AI or blockchain technology focuses on data protection and antitrust, the tools of private law should not be neglected. We hope to demonstrate their potential to deliver the benefits of "Law by Algorithm" for all with this book.

We are indebted to friends and colleagues who commented extensively on drafts of the papers which made it into this volume. Horst Eidenmüller co-authored a paper with John Armour and another one with Faidon Varesis. We are grateful for their permission to use these articles in this volume. The editing process was conducted by research assistants at Gerhard Wagner's Chair in Berlin. We thank them for their diligent work. We are especially indebted to Peter McColgan who supervised the editing process and also made many valuable comments and suggestions on the book's chapters. Leonie Steffen did superb work in the proofreading stages and created the Index. Special thanks go to Conor McLaughlin who reviewed most chapters and made many valuable suggestions. Finally, Horst Eidenmüller is grateful for a Fellowship of the Bavarian Research Institute for Digital Transformation (bidt) which allowed him to focus on this project in 2021.

This is a work of humans not machines. Hence, it surely contains many errors and shortcomings. We look forward to engaging with your comments and criticisms.

Oxford and Berlin,
October 2021

Horst Eidenmüller and Gerhard Wagner

Table of Contents

Chapter 1

Law by Algorithm*

This book ("Law by Algorithm") is about a fundamental change in the fabric of our societies, namely, the influence of digitization, blockchain technology and Artificial Intelligence (AI) on lawmaking, legal scholarship, and legal practice.

Throughout history, laws were made exclusively by humans and for humans. In democracies, members of parliaments debate new rules and regulations and eventually enact new laws. In totalitarian states, dictators or the members of the ruling caste do likewise. Human-made laws regulate human affairs and enable human activities, both in the private sphere and in business. Human judges interpret these laws, fill gaps or develop new rules. Law firms consisting of human attorneys assist clients in enforcing their rights and courts in developing the law. There is no question that legal systems around the world are anthropocentric.

This is not surprising. After all, we live in human societies, and laws structure our interactions in these societies. True, laws also structure human relations with machines, i. e. property. However, that confirms rather than refutes the human-centeredness of our legal systems.

At the same time, this human-centeredness creates well-known problems. One of them is, of course, climate change. For centuries, the focus of human laws has been on the welfare of other living humans. Effects on animals, the inanimate environment and on future generations have largely been ignored.

A very different problem relates to the process of human lawmaking and legal practice. Humans do not operate as flawlessly as well-oiled machines. We suffer from systematic irrationalities and biases in our decision-making.[1] Judges, too, are not immune to these shortcomings.[2] Further, human lawmaking or judging can be slow, cumbersome and costly. Can technology bring about improvements?

The answer to this question is a clear "Yes". Legal systems as we know them are changing under the influence of new technologies, at an accelerating pace, and for the better.

---

* Prepared for this volume by Horst Eidenmüller and Gerhard Wagner.

[1] For a comprehensive account *see*, *for example*, Daniel Kahneman, Thinking, Fast and Slow (2012).

[2] *See*, *for example*, Eyal Peer & Eyal Gamliel, *Heuristics and Biases in Judicial Decisions*, 49 Court Review 114 (2013); Lee Epstein & Stefanie A. Lindquist (eds.), The Oxford Handbook of U. S. Judicial Behavior (2017).

Digitization, i. e. the process of converting information into a digital (computer-readable) format, is not a new phenomenon. However, digitization has been turbocharged in the last two years by the COVID-19 pandemic. The pandemic has shown all of us the potential (as well as the limitations and drawbacks) of "doing things online", including in legal matters – from filing an application for a vaccination appointment to shopping on the Internet for daily supplies or even attending a virtual court hearing.

Roughly ten years before the pandemic, two other technological developments had started to influence commerce and the legal system, namely blockchain technology and advances in AI. A blockchain is a growing list of records ("blocks"), which are linked together using cryptography.[3] Many will associate blockchain technology primarily or even exclusively with the digital currency Bitcoin. A few months ago, for example, the carmaker Tesla announced that it will accept payments in Bitcoin for its cars in certain circumstances.[4] But blockchain applications go much beyond digital currencies. South Korea (and other countries) uses the same technology for its digital vaccine-passport, for example.[5]

Whereas the blockchain is used to automatically execute decisions, AI applications help us make better decisions. The greatest advances in this respect have been associated with a specific form of AI, namely Machine Learning (ML). ML is able "… to adapt to new circumstances and to detect and extrapolate patterns".[6] For example, AI applications based on ML allow us to predict the outcome of legal cases with great accuracy[7] or assist (human) judges in making better decisions, for example regarding the question of whether to grant bail in criminal law.[8] The list of law-related ML applications is already very long, and the numbers are growing rapidly – in all areas of the law.

The impact of new technologies such as digitization, AI, and blockchain on lawmaking, legal scholarship, and legal practice obviously raises a host of important questions.

---

[3] *See*, *for example*, Primavera De Filippi & Aaron Wright, Blockchain and the Law: The Rules of Code 1–9 (2018).

[4] *See* Reuters, *Musk says Tesla will accept bitcoins when miners use more clean energy*, June 13, 2021, https://www.reuters.com/technology/musk-says-tesla-will-accept-bitcoins-when-miners-use-reasonable-clean-energy-2021-06-13/ (last visited on June 28, 2021).

[5] *See* Sangmi Cha, *South Korea to issue blockchain-protected digital 'vaccine-passports'*, Reuters, April 1, 2021, https://www.reuters.com/article/us-health-coronavirus-southkorea-idUSKBN2BO43W (last visited on June 25, 2021).

[6] Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach 2 (3rd ed. 2016).

[7] *See*, *for example*, "ArbiLex", https://www.arbilex.co/welcome (last visited on June 25, 2021). On algorithmic predictions *see generally* Ajay Agrawal, Joshua Gans & Avi Goldfarb, Prediction Machines (2018).

[8] *See* Jon Kleinberg et al., *Human Decisions and Machine Predictions*, available at https://cs.stanford.edu/people/jure/pubs/bail-qje17.pdf (last visited on June 25, 2021).

Firstly, what exactly is happening in terms of technological developments, and what are the law-related developments that we can observe? Understanding these developments as comprehensively and precisely as possible on an empirical level is paramount to solidly grounding whatever normative inquiry of the relevant issues one pursues.

Secondly, which new challenges to legal doctrine arise? For example, already in 2017, the European Parliament passed a resolution calling on the European Commission to consider "... creating a specific legal status for robots in the long run, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons ..."[9]

Thirdly, which new regulatory challenges arise? In particular, is there a need to provide for mandatory safeguards to protect less sophisticated parties, especially consumers, from being exploited by powerful corporations?[10] Is there a risk of new forms of discrimination to the detriment of certain minority groups by "smart algorithms"?[11]

And fourthly, what use can societies make of AI in lawmaking and the application of laws? What is the potential of "eGovernment"?[12] Are "Online Courts" on the horizon anytime soon?[13]

In this book, we engage with these questions. The majority of the book's chapters have already appeared elsewhere as articles, and we acknowledge the original publication in the first footnote of each chapter and at the end of the book. For publication in this book, these articles have been updated in respect of the sources cited. However, no substantive changes have been made. The book also contains two new contributions, which have not appeared elsewhere before, namely Chapter 7 on "AI Liability" and Chapter 10 on "Digital Dispute Resolution".

The ordering of the chapters is as follows: In Chapters 2 and 3 ("The Rise of Robots and the Laws of Humans", "Machine Performance and Human Failure: How Shall We Regulate Autonomous Machines?"), we analyze conceptual and philosophical questions of "robot law". In Chapter 4 ("Down by Algorithms? Siphoning Rents, Exploiting Biases, and Shaping Preferences: Regulating the Dark Side of Personalized Transactions") we investigate the (potentially negative) impact of Big Data and AI applications on consumer welfare. Chapters 5, 6 and 7 ("Robot Liability", "Robot, Inc.: Personhood for Autonomous Systems?", "AI Liability") examine liability questions related to the rise of autonomous systems and associated conceptual issues. Chapter 8 ("Self-

[9] *See* European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), at no. 59 f), OJ C 252/239.

[10] *See* Shoshana Zuboff, The Age of Surveillance Capitalism (2019).

[11] *See* Cathy O'Neil, Weapons of Math Destruction (2016).

[12] The European Commission, for one, is taking actions to develop cross-border digital public services, *see* European Commission, eGovernment and digital public services, https://digital-strategy.ec.europa.eu/en/policies/egovernment (last visited on June 26, 2021).

[13] *See* Richard Susskind, Online Courts and the Future of Justice (2019).

Driving Corporations?") deals with the impact of AI on Corporate Governance issues and Corporate Law. The final two chapters focus on dispute resolution. Chapter 9 ("What is an Arbitration? Artificial Intelligence and the Vanishing Human Arbitrator") assesses the prospects for "driverless arbitrations", and Chapter 10 ("Digital Dispute Resolution") deals with smart contracts and digital enforcement, internal complaint handling, Online Dispute Resolution (ODR), and the role of the courts in a world shaped by digitization, blockchain technology and AI applications.

Given that the majority of the chapters have appeared as individual articles, it is inevitable that certain issues and themes are treated in more than one chapter. We view this as a benefit, as the reader can see how our thinking on certain issues has evolved. It also reveals different insights to be gained from different perspectives on the same or similar issues. Another beneficial feature of our approach is related to the fact that the articles have different authors, and only a few are co-authored by the authors of this book. As a consequence, certain issues are treated differently in the individual chapters, for example the usefulness or even necessity of an economic analysis when thinking about "robot liability". This should enrich the book and make for a livelier reading, we hope.

If there is one recurring theme in all chapters it is how "Law by Algorithm" helps to massively increase the welfare in our societies and, at the same time, creates the significant risk that this increased welfare benefits only a few of its members.

On the one hand, the benefits digitization, blockchain, and AI bring to our legal systems are huge. We will be able to conclude smarter contracts, which better satisfy our needs, interact with one another and public institutions much more efficiently, and benefit from much improved dispute resolution services. Laws can be "personalized" in the sense that private and public rules are calibrated to the needs and preferences of individual members of society.[14]

On the other hand, it also seems clear that not all parties will benefit from this development to the same degree. We do not believe that futuristic visions of a world populated by robots with legal personality will become a reality anytime soon. But we do believe that sophisticated private actors will increasingly use the new technological tools to enrich themselves, at the expense of less sophisticated market participants, especially consumers. In fact, this is already happening right now, and the velocity and impact of the development is staggering.

The greatest beneficiary of digitization, blockchain technology and smart AI applications is Big Tech, i. e. Google, Apple, Facebook, Amazon and Microsoft. Facebook is or has been the subject of investigations by antitrust agencies in Europe and the United States.[15] The company is widely criticized for its business

[14] *See* Omri Ben-Shahar & Ariel Porat, Personalized Law: Different Rules for Different People (2021).

[15] For Germany *see*, *for example*, Bundeskartellamt (Federal Monopolies Commission),

model of aggressively collecting and analyzing the personal data of its users for profit, and for the commercial gain of its business partners.[16] Another tech power player is Amazon: shaping consumers' preferences, exploiting their biases, engaging in first-degree price discrimination, and handling any disputes by an effective but biased internal complaint handling algorithm (see Chapters 4 and 10 in this volume). The European Commission has initiated antitrust proceedings against Amazon for abuse of a dominant position.[17] In the United States, Amazon now faces the first serious antitrust action for allegedly breaking the law by unfairly crushing competition.[18] And there is more to come: A law review article written by the FTC's newly elected chairperson reads like a playbook on how to restrict Amazon's monopoly power – perhaps by employing elements of public utility regulation.[19]

On the legislative front, the United States Congress is about to discuss and possibly enact a package of five legislative acts aimed not only to restore competition in the digital marketplace, but also to "rein in" the largest tech platforms.[20] The proposed "American Innovation and Choice Online Act" is designed to prohibit and sanction discrimination on online platforms, while the so-called "ACCESS Act" calls for interoperability and data portability. On the other side of the Atlantic, the European Union has already passed a legislative instrument which regulates the conduct of online platforms vis-à-vis commercial customers, i. e. the P2B Regulation 2019/1150.[21] In essence, its purpose is to ensure non-dis-

---

Resolution of February 6, 2019, Case B6–22/16; Oberlandesgericht (Higher Regional Court) Düsseldorf, Decision of August 26, 2019, VI-Kart 1/19 (V), Neue Zeitschrift für Kartellrecht 2019, 495; Bundesgerichtshof (BGH) (Federal Court of Justice) June 23, 2020, KVR 69/19, Neue Zeitschrift für Kartellrecht 2020, 473. As to the U. S. *see* FTC v. Facebook, Inc., No. 1:20-cv-03590-JEB (D. D. C. Jan. 13, 2021), https://www.ftc.gov/system/files/documents/cases/051_2021.01.21_revised_partially_redacted_complaint.pdf (April 22, 2021) (press release available at: https://www.ftc.gov/news-events/press-releases/2020/12/ftc-sues-facebook-illegal-monopolization (last visited on June 30, 2021)).

[16] *See*, *for example*, Bernard E. Harcourt, Exposed: Desire and Disobedience in the Digital Age 3–7, 21–24, 42–46 (2015); Brad Smith & Carol Ann Browne, Tools and Weapons: The Promise and the Peril of the Digital Age 89–107 (2019).

[17] European Commission, Case AT.40562 – Amazon Marketplace; European Commission, Case AT.40703 – Amazon – Buy Box.

[18] *See* Shira Ovide, *The Big Deal in Amazon's antitrust Case*, New York Times, May 25, 2021, available at https://www.nytimes.com/2021/05/25/technology/amazon-antitrust-lawsuit.html (last visited on June 26, 2021).

[19] *See* Lina Khan, *Amazon's Antitrust Paradox*, 126 Yale L. J. 710, 797–802 (2017). *See also* Tim Wu, The Curse of Bigness: Antitrust in the New Gilded Age (2018).

[20] *See* David Cicilline, *House Lawmakers Release Anti-Monopoly Agenda for "A Stronger Online Economy: Opportunity, Innovation, Choice"*, June 11, 2021, available at https://cicilline.house.gov/press-release/house-lawmakers-release-anti-monopoly-agenda-stronger-online-economy-opportunity (last visited on June 30, 2021).

[21] Regulation (EU) 2019/1150 on promoting fairness and transparency for business users of online intermediation services, OJ L 186/57; *see* Martin Eifert et al., *Taming the Giants: The DMA/DSA Package*, 58 Common Mkt. L. Rev. 987 (2021).

crimination, transparency, and fairness in the commercial relationships between platforms and business users. While the P2B Regulation mostly confines itself to disclosure mandates, the recently published proposal of a Digital Markets Act[22] goes much further. If enacted, it would subject the tech giants, the so-called gatekeeper platforms, to rather strict duties of equal treatment, easy access, and fair dealing, together with a prohibition of "self-preferencing".

Despite this flurry of activity, antitrust is a blunt instrument, and it comes very late in the game.[23] Traditional antitrust remedies such as breakup are like a massive operation after the problem has almost gotten out of control. Societies must apply more and different tools on a "micro level" in different areas of the law to make sure that the benefits of new technologies accrue to the many and not just the few. With the proposal of the Digital Markets Act, Europe is moving in this direction, and it seems that the United States is about to follow.

However, the challenges for private law, and the legal system more generally, remain. Statutes like the Digital Markets Act are just one puzzle piece in the appropriate regulatory response to Big Tech. Arguably, the law should protect consumers (and SMEs) who increasingly conduct their commercial and personal affairs in the digital space much more vigorously and much earlier, i. e. before their lives and opportunities have been seriously limited by powerful private counterparties that have reached "Amazon status". Making "Law by Algorithm" work for (all) humans is an enormous challenge and responsibility.[24] We hope to contribute to this task with the chapters in this book.

[22] Proposal for a Regulation on contestable and fair markets in the digital sector ("Digital Markets Act"), COM(2020) 842 final; *see also* Eifert et al. (*supra* note 21).

[23] *Cf.* Ariel Ezrachi & Maurice E. Stucke, Virtual Competition: The Promise and the Perils of the Algorithm-Driven Economy 218–232 (2016) (rightly suggesting that "we must be open-minded to new enforcement instruments", *id.* at 219).

[24] *See*, *for example*, Max Tegmark, Life 3.0: Being Human in the Age of Artificial Intelligence (2017); Frank Pasquale, New Laws of Robotics: Defending Human Expertise in the Age of AI (2020); Joshua A. T. Fairfield, Runaway Technology (2021). For a broader perspective *see* Brett Frischmann & Evan Selinger, Re-Engineering Humanity (2018); Yuval Noah Harari, 21 Lessons for the 21st Century 9–98 (2018).

Chapter 2

The Rise of Robots and the Law of Humans*

In this chapter, I examine fundamental questions raised by the rise of robots and the emergence of "robot law". The main theses developed are the following: (i) robot regulation must be robot- and context-specific. (ii) (Refined) existing legal categories are capable of being sensibly applied to and regulating robots. (iii) Robot law is shaped by the "deep normative structure" of a society. (iv) If that structure is utilitarian, smart robots should be treated like humans. (v) The case against treating robots like humans rests on epistemological and ontological arguments. I develop these theses primarily in the context of accident liability for self-driving cars.

I. Artificial Intelligence (AI) and the law

When lawyers enter the discussion, the fun part is usually over. Engineers and computer scientists enjoy a similar reputation. In this chapter, I consider robots and the law. The prospects for entertainment may therefore be limited. However, the interaction of law and Artificial Intelligence (AI) poses exciting and important questions, and the answers to these questions will undoubtedly shape the future of mankind in the decades to come.

AI is now rapidly changing how we live and work. As routine tasks (both manual and cognitive) become increasingly automated, it is anticipated that robots ("embodied AI"[1]) will take approximately 1/3 of jobs in traditional professions by 2025.[2] The law will shape the future of AI. It will determine the permissible uses of AI, the costs of new products and technologies, among other things. Further, the initial regulatory decisions will be crucial. They may create path dependencies, and make it hard to change regulatory course later.

Regulating AI is going to be challenging and difficult. After all, the law is – and always has been – made by humans and for humans. Just think of fundamental

---

* Originally published under Horst Eidenmüller, *The Rise of Robots and the Law of Humans*, Zeitschrift für Europäisches Privatrecht 765 (2017).

[1] *See* Ryan Calo, *Robotics and the Lessons of Cyberlaw,* 103 Cal. L. Rev. 513, 532 et seq. (2015).

[2] *See* Christoffer O. Hernaes, *Artificial Intelligence, Legal Responsibility and Civil Rights*, Techcrunch, Aug. 22, 2015, https://techcrunch.com/2015/08/22/artificial-intelligence-legal-responsibility-and-civil-rights/. For a thorough treatment of the problem including sensible policy options, *see* Martin Ford, The Rise of Robots: Technology and the Threat of Mass Unemployment (2015).

concepts such as "personhood" and "legal personality". Historically, these concepts related to humans, i. e. natural persons. AI will thus strain the legal system: How shall we deal with robots? Shall we accord them legal personality, give them the right to acquire and hold property and to conclude contracts, etc.?[3]

In this chapter, I attempt to answer these and other fundamental questions raised by the rise of robots and the emergence of "robot law". The main theses developed in this chapter are the following: (i) robot regulation must be robot- and context-specific. This requires a profound understanding of the micro- and macro-effects of "robot behavior" in specific areas. (ii) (Refined) existing legal categories are capable of being sensibly applied to and regulating robots. (iii) Robot law is shaped by the "deep normative structure" of a society. (iv) If that structure is utilitarian, smart robots should, in the not-too-distant future, be treated like humans. This means that they should be accorded legal personality, have the power to acquire and hold property and to conclude contracts. (v) The case against treating robots like humans rests on epistemological and ontological arguments. These relate to whether machines can *think* (they cannot), and what it *means* to be human.

I will develop these theses primarily in the context of self-driving cars – robots on the road with a huge potential to revolutionize our daily lives and commerce.[4] However, in order to illustrate the massive potential influence that robots will have on the fabric of our societies, I begin with a broader range of examples.

II. Varieties of robots and robot features

A. Robot applications

Self-driving cars are currently among the most discussed robot developments.[5] Indeed, most car manufacturers have experimented with self-driving cars, and these cars are already being tested on roads worldwide.[6] Google appears to have the lead in this development.[7] A key feature of its car is a rotating rooftop camera. It consists of an array of 64 laser beams that create 3D images of objects,

[3] For a summary of the issues, *see*, *for example*, Jens Kersten, *Menschen und Maschinen*, 70 JuristenZeitung 1, 6–8 (2015).

[4] *See* Horst Eidenmüller, *Whose Fault? Firms, Products and Liability in the Age of Artificial Intelligence, BMW Welcomes: Artificial Intelligence*, Youtube, April 21, 2016, https://www.youtube.com/watch?v=WI0d6yzFG24.

[5] *See*, *for example*, Hod Lipson & Melba Kurman, Driverless: Intelligent Cars and the Road Ahead (2016).

[6] *See* "40+ Corporations Working On Autonomous Vehicles" (updated March 4, 2020), https://www.cbinsights.com/blog/autonomous-driverless-vehicles-corporations-list/.

[7] *See* "Waymo Bumps A Scooter – Roundup Of Self-Driving Car Headlines" (June 21, 2021), https://www.forbes.com/sites/bradtempleton/2021/06/21/waymo-bumps-a-scooter-roundup-of-self-driving-car-headlines/?sh=9c34a8666511.

allowing the car to orient itself. The car's driving behavior is controlled by complex software.

Another important application of robots is in medicine. For instance, prototypes of nanotech medical robots with a size of a 1–10/1,000,000 of a millimeter have been developed.[8] These nanotech robots will travel through a patient's blood and into tumors where they will deliver a therapy that turns off an important cancer gene.

Robots are also beginning to enter the finance and financial consulting industry. "Robo financial advisers" might shake up the brokerage business with low-cost, automated investing.[9] For example, UBS recently announced that advisers in its American wealth management division will use a robot to cater to wealthy clients.[10] This technology, which will be used by the company's 7,000 advisers, has been developed by a San Francisco start-up, SigFigWealth Management, which is one of a growing group of robo-advisers.[11]

Finally, AI is also going to fundamentally change the legal profession.[12] Indeed, AI systems already assist in the (automated) resolution of disputes,[13] and "robo-lawyers" are entering the stage. In 2016, for example, the world's first artificially intelligent lawyer was hired by a US law firm, BakerHostedler, which licensed ROSS Intelligence for use in its bankruptcy restructuring and creditor rights department.[14] "Robo-lawyers" will be deployed especially with respect to document searches and classification in discovery.[15] In England, predictive coding (classification of documents for discovery) was recently backed by the

[8] *See* Mike Chino, *Nanotech Robots Travel Through Blood to Turn Off Tumor Cells*, Inhabitat, March 25, 2010, http://inhabitat.com/nanotech-robots-travel-through-blood-to-turn-off-tumor-cells/.

[9] *See* Tara Siegel Bernard, *Should a robot oversee your retirement money?*, New York Times, May 3, 2016, 15.

[10] *See* Alessandra Amalito, *UBS to offer SigFig's robo-platform to its financial advisers*, Investment News, May 9, 2016, http://www.investmentnews.com/article/20160516/FREE/160519939/ubs-to-offer-sigfigs-robo-platform-to-its-financial-advisers.

[11] *See* https://www.sigfig.com/site/#/home/am (last visited on November 20, 2020).

[12] *See* Dana Remus & Frank S. Levy, *Can Robots Be Lawyers? Computers, Lawyers, and the Practice of Law*, November 30, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2701092; Richard Susskind & Daniel Susskind, The Future of the Professions: How Technology will Transform the Work of Human Experts 66–71 (2015); Jerry Kaplan, Humans Need Not Apply: A Guide to Wealth and Work in the Age of Artificial Intelligence 145–149 (2015).

[13] *See* Shaheen Fatima et al., Principles of Automated Negotiation (2014). For a detailed discussion *see*, Horst Eidenmüller & Gerhard Wagner, *Digital Dispute Resolution*, *infra* Chapter 10 in this volume, 223.

[14] *See* Chris Weller, *The world's first artificially intelligent lawyer was just hired at a law firm*, Business Insider, May 16, 2016, http://www.businessinsider.com/the-worlds-first-artificially-intelligent-lawyer-gets-hired-2016-5?IR=T.

[15] *See* Julie Sobowale, *How artificial intelligence is transforming the legal profession*, ABA Journal, April 1, 2016, http://www.abajournal.com/magazine/article/how_artificial_intelligence_is_transforming_the_legal_profession.

High Court in *Brown vs BCA Trading* on 17 May 2016.[16] "Robo-lawyers" will also be involved in the (online) drafting of legal documents[17], and "smart contracts" based on blockchain technology are around the corner.[18]

AI might also come in the form of "robo-judges". Based on a data set of 150,000 US felony cases, *Kleinberg et al.* found that a release rule (pending resolution of the cases) based on machine learning predictions would enable us to reduce the jail population by 25 % without any increase in the crime rate, or let us reduce crime rates by 20 % without changing the jail population.[19] Taken together, robo-lawyering and judging seem to bring significant positive developments in making legal advice more affordable, judging more accurate, and improving access to justice for many.

B. Robot features

Reflecting on the examples discussed above, certain "robot features" emerge that are important when thinking about regulating robots. As already mentioned, robots are a form of embodied AI. They consist of a sensor or other input mechanism, a controlling algorithm, and the capacity to give feedback to the outside world.[20] These three features together constitute the so-called "Sense-Think-Act Paradigm".[21] The sensor or other input mechanism may draw from multiple sources as is the case, for example, with respect to "networked cars".[22] As described, they use cameras, traffic data from GPS, and geographical data taken from the internet.

Smart robots have machine learning capabilities, i. e. they not only use huge amounts of existing data, but also use data from experiences and other new information to adapt their behavior.[23] Therefore, to some extent, these robots are

---

[16] Brown v BCA Trading Ltd [2016] EWHC 1464 (Ch).

[17] On "computational law" *see*, *for example*, Jerry Kaplan, Artificial Intelligence: What Everyone Needs to Know 95–97 (2016).

[18] *See*, *for example*, Henning Diedrich, ethereum: blockchains, digital assets, smart contracts, decentralized autonomous organizations (2016); James Eyers, *Lawyers prepare for 'driverless M&A' as smart contract era dawns*, Financial Review, June 20, 2016, http://www.afr.com/technology/lawyers-prepare-for-driverless-ma-as-smart-contract-era-dawns-20160616-gpknyz; for a detailed discussion *see*, Horst Eidenmüller & Gerhard Wagner, *infra* Chapter 10 in this volume, 223, 228–235.

[19] *See* John Kleinberg et al., *Human Decisions and Machine Predictions* (NBER Working Paper No. 23180, February 2017), http://www.nber.org/papers/w23180.

[20] *See* A. Michael Froomkin, *Introduction*, in Robot Law x, xi (Ryan Calo et al. eds., 2016).

[21] *See, for example*, Henry Hexmoor, Essential Principles for Autonomous Robotics 25 (2013).

[22] *See*, *for example*, Sejoon Lim et al., *Intelligent Transportation with Networked Cars*, https://groups.csail.mit.edu/drl/wiki/images/0/0f/LimMobisysDemo08.pdf (last visited on October 15, 2021).

[23] *See* Ethem Alpaydin, Machine Learning: The new AI (2016); Erik Brynjolfsson & Andrew McAffe, The Second Machine Age: Work, Progress, and Pros-

unpredictable by design.[24] An interesting question is whether robots, at some point in time, might reach a super-human intelligence level.[25] This is often referred to as "singularity".[26] Robots might learn how they are controlled by humans, taking over control themselves. For the time being, though, the debate about "singularity" is more academic (and fictional) than real.

Amongst the various forms of robots, an import subclass is "social robots".[27] These are specifically designed for interactions with humans. Just think of toys for children that have human features.[28] Research has identified "social valence" of "social robots": humans treat anthropomorphic robots like humans.[29] This has potentially important regulatory consequences.

III. Regulating self-driving cars

A. The potential of self-driving cars

The first thesis developed in this chapter is that robot regulation must be "robot-context specific". It requires a profound understanding of the micro- and macro-effects of "robot behavior" in specific areas. I will illustrate this thesis through the example of accident liability for fully autonomous cars – a good test case for "robot law".

In 20 to 25 years, approximately 75 % of cars on the road will be self-driving.[30] There are a lot of significant positive developments associated with this trend.

---

perity in a Time of Brilliant Technologies 89–96 (2014); Kaplan, *supra* note 17, at 27 et seq. ("So four trends – improvements in computing speed and memory, the transition from physically to electronically stored data, easier access …, and low-cost high-resolution digital sensors – were prime drivers in the refocusing of efforts from symbolic reasoning to machine learning", *id.* at 39).

[24] *See* Jason Millar & Ian Kerr, *Delegation, relinquishment and responsibility: The prospect of expert robots*, in Robot Law 102, 107 (Ryan Calo et al. eds., 2016).

[25] *See generally* Nick Bostrom, Superintelligence: Paths, Dangers, Strategies (2014).

[26] *See id.* at 1–3; Ford, *supra* note 2, 225–245.

[27] *See* KPMG, *Social Robots: 2016's new breed of social robots is ready to enter your world* (2016), https://assets.kpmg.com/content/dam/kpmg/pdf/2016/06/social-robots.pdf (last visited on October 15, 2021).

[28] On such toys *see*, *for example*, *Netzagentur ruft Eltern auf, Puppe "Cayla" zu zerstören*, Süddeutsche Zeitung, February 16, 2017, http://www.sueddeutsche.de/digital/ueberwachung-im-kinderzimmer-netzagentur-ruft-eltern-auf-puppe-cayla-zu-zerstoeren-1.3383009.

[29] *See* Kate Darling, *Extending legal protection to social robots: The effects of anthropomorphism, empathy, and violent behaviour towards robotic objects*, in Robot Law 213, 216 et seq. (Ryan Calo et al. eds., 2016).

[30] *See* Kaplan, *supra* note 12, at 195 ("the expert consensus is that 75 percent of the vehicles on the road will be self-driving in twenty to twenty-five years"); Richard Gardiner, *Autonomous Car: The regulatory and liability challenges*, HopgoodGanim Lawyers Blog, April 8, 2016,

First, we are going to see significantly fewer car accidents and, even more importantly, fewer casualties: currently, approximately 1.3 million lives are lost every year in car accidents worldwide.[31] Approximately 90 % of these fatal accidents are caused by human fault, 7 % by environmental conditions and around 1 % by technical defects and maintenance issues.[32] Second, we are going to witness increased mobility of persons with disabilities, the elderly, etc. Third, the opportunity costs of driving will be significantly reduced. On average, we spend more than four years driving during our lifetime,[33] and we are not always driving cars that are supposed to give you "Sheer Driving Pleasure" like a BMW.[34] We could use the time spent behind the wheel for more productive activities like reading, thinking, or just dreaming. Fourth, we are going to see fewer cars on the streets because of car-sharing. This is going to free up parking space, reduce travel time and also emissions.

However, there are also negative developments. First, we are going to see more unemployment in certain professions. Taxi and bus drivers, for example, will clearly be affected. Second, there is a higher risk of "high magnitude accidents" occurring, since cars will be networked and therefore liable to devastating cyber attacks, etc.[35] Finally, the odd "small" accident will also occur, albeit rarely. Two such incidents happened in the first half of 2016. In one case, a Google car crashed into a bus in Mountain View, California, when trying to change lane.[36] The Google car suffered some damage, whereas the bus was scratched only very lightly. Much more serious damage occurred in another case, when a Tesla car in self-driving mode crashed into a lorry in Florida, killing the "driver" of the Tesla car.[37] Apparently, the sensor system in the Tesla failed to spot the approaching lorry.

---

https://www.hopgoodganim.com.au/page/knowledge-centre/blog/autonomous-car-the-regulatory-and-liability-challenges.

[31] *See* Jeffrey K. Gurney, *Sue my car not me: products liability and accidents involving autonomous vehicles*, Journal of Law, Technology & Policy 2013, 247, 250.

[32] *See* Statistisches Bundesamt, *Verkehr im Überblick* 36 (201), https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Transport-Verkehr/Publikationen/Downloads-Querschnitt/verkehr-ueberblick-2080120187004.pdf?__blob=publicationFile (last visited on July 1, 2020).

[33] *See* "30 Surprising Facts About How We Actually Spend Our Time" (January 7, 2015), https://infogram.com/30-surprising-facts-about-how-we-actually-spend-our-time-1g957prkr7w7m01 (last visited on June 23, 2021).

[34] *See* http://www.bmw.com/com/en/insights/brandcampaign_pleasure/experience.html?cm=Facebook (last visited on November 20, 2020).

[35] *See* Patrick Lin, *The Ethics of Autonomous Cars*, The Atlantic, October 8, 2013, https://www.theatlantic.com/technology/archive/2013/10/the-ethics-of-autonomous-cars/280360/.

[36] *Google self-driving car collides with bus in California, accident report says*, The Guardian, March 1, 2016, https://www.theguardian.com/technology/2016/feb/29/google-self-driving-car-accident-california.

[37] *See Tesla driver dies in first fatal crash while using autopilot*, The Guardian, July 1,

What the foregoing demonstrates, therefore, is that effective robot regulation must be tailor-made to the macro- and micro-impacts of such technologies – it must account for the social changes caused by *specific* robots, while also accounting for the risks and opportunities arising day-to-day.

B. Accident liability for fully autonomous cars

I will now proceed to use the issue of accident liability for fully autonomous cars to develop my second thesis: that (refined) existing legal categories are capable of being applied to robots, to sensibly regulate their behavior. Specifically, the question I would like to pose and answer is: who shall be liable *in tort* if an accident occurs? I will not examine how existing legal systems would deal with the issue right now;[38] rather, I am interested in the best "solution" if one were *to design* a liability system from scratch. Thus, I will look at various possibilities: (i) nobody is liable ("the loss is where it falls"), (ii) the car manufacturer is liable, (iii) the AI (device) producer is liable (if different from the car manufacturer), (iv) the car owner is liable (there are no "drivers" with respect to fully autonomous cars), and, finally (v), the car itself is liable. It might appear to be quite fanciful to consider the last option. But things are evolving rapidly. In 2015, a robot that was part of an art installation in Switzerland bought ecstasy and a fake Hungarian passport, amongst other things, on the dark web.[39] The robot, not the artist or another human, was arrested by the St. Gallen police and freed after three months.

In view of the above five options, it appears that strict liability of the car manufacturer – i. e. regulatory option two – should be preferred, and for several reasons.[40]

To begin, holding nobody liable certainly would not be an acceptable solution. Expected (accident) costs would not be internalized by the producers. Hence, they would have the wrong incentives, producing too many cars at too low costs and prices. At the same time, we would be very reluctant to buy and/or use autonomous cars under a "no liability regime", and might even refrain from such activity altogether.

2016, https://www.theguardian.com/technology/2016/jun/30/tesla-autopilot-death-self-driving-car-elon-musk.

[38] For the US *see* Gurney, *supra* note 31, at 257–271; Curtis E. A. Karnow, *The application of traditional tort theory to embodied machine intelligence*, in Robot Law 61–74 (Ryan Calo et al. eds., 2016); for Germany *see* Hans Schulte-Nölke, *Europäisierung des Haftungsrechts*, in Karlsruher Forum 2015: Europäisierung des Haftungs- und des Versicherungsvertragsrechts 3, 31 et seq. (Egon Lorenz ed., 2016); Lennart S. Lutz, *Autonome Fahrzeuge als rechtliche Herausforderung*, Neue Juristische Wochenschrift 2015, 119, 119–121.

[39] *See That robot who bought ecstasy and a fake passport online is finally out of prison*, Splinter, April 17, 2015, http://fusion.net/story/122192/robot-that-bought-ecstasy-and-a-fake-passport-online-released-from-swiss-prison/.

[40] *See* Eidenmüller, *supra* note 4; Horst Eidenmüller, *Wenn Maschinen töten*, Süddeutsche Zeitung at 2, July 13, 2016.

Under a regime of strict liability of the car manufacturer, no fault would be required to establish liability, just a defective product and causation. The manufacturer seems to be best positioned to control risks and balance the benefits and costs of the technologies that are "driving" fully autonomous cars: the manufacturer develops and uses the AI, and it has an intimate knowledge of the relevant technologies. This is apparent, for example, from the immediate and sophisticated reaction of Google to the car accident described above. Google was very quickly able to identify what had caused the problem.[41]

Further, in contrast to a strict liability regime, a fault-based liability regime of the car manufacturer would require the courts to determine the proper amount of care to be exercised when manufacturing and selling autonomous cars. This, as with all new and complex technology, is a very difficult exercise. Further, a fault-based liability regime does not control the "activity level" of the producer, i. e. the number of cars produced and sold.[42] Hence, a strict liability regime seems to be the better option.

What about regulatory option three, i. e. liability of the AI (device) producer if this producer is different from the car manufacturer? I submit that it would be very difficult to disentangle the accident causes in complex technology products, as a general matter, and with respect to fully autonomous cars, in particular. Also, the car manufacturer "controls" the system, including all component parts. Hence, the car manufacturer probably is the cheapest cost avoider.[43] As far as tort liability vis-à-vis third parties is concerned, it should therefore be the only liability addressee. Of course, the car manufacturer could seek indemnity from the device producer based on their contractual relationship if a defective AI device ultimately caused an accident. Holding the car manufacturer strictly liable involves the risk of the manufacturer falling insolvent, and therefore not being able to pay up. To cover this risk, manufacturers should be required by the law to purchase product liability insurance.

Indeed, the "solution" to the liability problem developed above seems to be the one towards which the market and private contracting practice is moving. Late in 2015, for example, Volvo announced that it would take responsibility for the actions of its self-driving cars.[44] With this announcement, Volvo sent a

[41] *See* "Google self-driving car crashes into a bus (update: statement)", (February 29, 2016), https://www.engadget.com/2016/02/29/google-self-driving-car-accident/ (last visited on June 23, 2021).

[42] *See*, *for example*, Howell Jackson et al., Analytical Methods for Lawyers 404–405 (2003).

[43] If parties were able to bargain for the applicable liability rule at zero (transaction) costs, they would contract for liability of the party that is best positioned to avert the expected accident costs at the lowest costs (Coase Theorem). *See* Ronald Coase, *The Problem of Social Cost*, 3 J. L. & Econ. 1 (1960).

[44] *See* Kirsten Korosec, *Volvo CEO: We will accept all liability when our cars are in autonomous mode*, Fortune, October 7, 2015, https://fortune.com/2015/10/07/volvo-liability-

strong signal to the market: we have confidence in our own technology. That signal created a lot of pressure on competitors to follow suit.[45] The "solution" developed above also largely mirrors the legal status quo under the Product Liability Directive 85/374/EEC in the European Union, with one exception: under the Directive, both the manufacturer of the car and the manufacturer of the component part would be jointly and severally liable (Arts. 3 (1), 5, 7 (f)).[46]

One problematic aspect of a strict tort liability regime that holds the car manufacturer liable for accidents caused is the activity level of owners of autonomous cars. Thus, it is clear that the likelihood of accidents very much depends on the activity level: the more often a car is on the road, the more accidents will happen. It is likewise clear that the owner controls this activity level, depending on his or her personal preferences, business model, etc. Just think of a taxi company on the one hand and a private car owner on the other hand. Hence, controlling the activity level of car owners is thus an important element of an efficient liability regime.[47]

One can think of various potential "solutions" to this problem. One would be co-liability of owners depending on their activity profile. Another could be tying the sale of the car to liability insurance with the premium determined by (i) the manufacturer, (ii) the type of car, and (iii) the owner/user profile. Such personalized insurance is available already today. It is often called "black box insurance" because cars are fitted with a small "black box" device, about the size of a smartphone, which records speed, distance travelled and the time of day or night that the car is on the road.[48] The device also assesses driving style

self-driving-cars/#:~:text=For%20Volvo%20Car%20Group%2C%20the,cars%20is%20in%20autonomous%20mode.

[45] However, on March 27, 2017 BMW Group and Allianz Worldwide Partners announced that they support the principle that car owners should be liable for accidents caused by fully autonomous vehicles, *see* https://www.allianz-partners.com/content/dam/onemarketing/awp/azpartnerscom/press-releases/2017/BMW-Group-and-AWP-joint-position-on-liability-laws-to-be-suitable-for-future-automated-vehicles.pdf (last visited on November 13, 2020). As demonstrated in the text *supra* and *infra* this is not the efficient "solution" to the liability problem. However, *prima facie* cars will be cheaper under an "owner pays" regime, and inexperienced buyers might fail to notice that they have to add the insurance premium to the purchase price (which will be higher than under the "manufacturer pays" regime because the "owner pays" regime is less efficient). Also, Allianz will receive higher premia.

[46] Under the Directive, the component manufacturer is not liable if the defect is attributable to the design of the product or to instructions by the manufacturer regarding the final product. Liability under the Directive is for damage caused by death or by personal injuries or damage to property other than the defective product itself, Art. 9. The liability regime under the Directive does not affect contractual liability, Art. 13.

[47] *See*, *for example*, Steven Shavell, *Liability for Accidents*, in 1 Handbook of Law and Economics 139, 146 et seq. (A. Mitchell Polinsky/Steven Shavell eds., 2007).

[48] *See*, *for example*, http://www.rac.co.uk/insurance/car-insurance/black-box-insurance (last visited on November 20, 2020); https://www.confused.com/car-insurance/black-box/telematics-explained (last visited on November 20, 2020).

by monitoring speeding and cornering. It further records the types of roads on which the car typically travels, and the times of day and night on which it is in operation, to build up a comprehensive driving profile.

IV. Treating smart cars (machines) like humans?

So far, I have not discussed option five of the potential regulatory responses to accidents caused by fully autonomous cars, namely holding the car itself liable. However, this problem may be used to illustrate the third thesis of this chapter: that robot law is and will be shaped by the "deep normative structure" of a particular society.[49] For example, how does a society's normative structure affect the response to the problem posed above, if this structure is utilitarian?[50]

As has already been mentioned, manufacturers cannot (fully) foresee the behavior of smart cars because of Machine Learning. This is the starting point for thinking that we might, at some point in time, therefore, be forced to excuse the car manufacturer and instead hold *the car itself* liable. Conceptually, this would imply that we would acknowledge that a car has legal capacity. If it can be liable, we might conclude that it should also have the power to acquire property, conclude contracts, etc. Indeed, against a utilitarian background, there are a number of arguments that would seem to support moving in this direction.

First, smart cars *appear* (functionally) capable of purposive actions. They exhibit what can be called "moral" or "legal" agency, i. e. smart cars act similarly as humans would act in similar situations.[51] Second, we *treat* anthropomorphic robots like humans. Should we not then give them rights to send a signal against mistreatment of humans generally?[52] Protecting robots in this way would have a beneficial feedback effect on human interaction. Third, we accord corporations legal personality. There is a long debate amongst legal scholars whether corporate personality is based on a fiction (as *von Savigny* argued[53]) or whether there

[49] *See also* Eidenmüller, *supra* note 4; Eidenmüller, *supra* note 40; Horst Eidenmüller, *Robots' Legal Personality*, Oxford Business Law Blog, March 8, 2017, https://www.law.ox.ac.uk/business-law-blog/blog/2017/03/robots'-legal-personality.

[50] An uncritical utilitarian perspective is adopted, *for example*, by Jan-Erik Schirmer, *Rechtsfähige Roboter?*, 71 JuristenZeitung 660, 663 et seq. (2016) ("[Roboter] sind insoweit rechtsfähig, wie es zweckmäßig ist, also immer dann, wenn entweder ihre Einordnung als selbständiger Akteur zu ihrem Schutz notwendig ist oder für den Rechtsverkehr einen Mehrwert bringt."). However, utilitarianism is of course a much disgraced legal philosophy. *See*, *for example*, Horst Eidenmüller, Effizienz als Rechtsprinzip: Möglichkeiten und Grenzen der ökonomischen Analyse des Rechts 187 et seq. (4th ed. 2015).

[51] Kaplan, *supra* note 12, at 87.

[52] *See* Darling, *supra* note 29, at 226–229.

[53] *See* Friedrich Carl von Savigny, 2 System des heutigen Römischen Rechts 236 (1840) ("Die Rechtsfähigkeit wurde oben dargestellt als zusammenfallend mit dem Begriff des einzelnen Menschen (§ 60). Wir betrachten sie jetzt als ausgedehnt auf künstliche, durch